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## TEMPORARY CONTAMINATION OF A DEEP WELL SUPPLY AT MONTGOMERY, ALABAMA<sup>1</sup>

BY G. H. HAZLEHURST<sup>2</sup>

There was a phenomenal rainfall in Alabama from the night of December 7 until the morning of December 10, 1919. A precipitation of 9.6 inches was recorded at Montgomery for this period, with like amounts for Selma, Birmingham, Gadsden, Lanett and other points. The Coosa and Tallapoosa rivers rose with unprecedented rapidity, until a flood stage of 57.1 feet was reached on the Alabama River, the highest water recorded since 1886. The north portion of Montgomery was flooded, the water reaching the roofs of the houses in many places. Not realizing the situation, the operating engineer at the water works left at his usual time on the evening of December 9. He was called to the plant just before the water began entering at 1.30 a.m. of December 10. Trouble was experienced in operating, as the water was kept out of the motors with great difficulty, and it stood from 1 to 2 feet over the north yard where there are four 52-foot circular concrete storage reservoirs, 20 feet deep.

Montgomery is supplied with water from 18 deep wells in the north portion of the city and two in the east portion. The northern wells draw water from depths varying from 200 to 600 feet and are pumped by air. These wells discharge into the four circular concrete reservoirs, with a combined storage capacity of approximately 1,200,000 gallons. From these basins the water is pumped to the mains, at the rate of about 3,000,000 gallons per 24 hours. The two eastern wells draw water from depths of 75 and 135 feet respectively. These have an approximate capacity of 2,000,000 gallons per twenty-four hours, and are pumped by submerged, vertical multi-stage deep well centrifugal pumps, electrically driven, operating normally at 125 pounds pressure and discharging directly into the mains.

<sup>1</sup>Discussion of this paper is requested and should be sent to the Editor.

<sup>2</sup>Sanitary Engineer, State Board of Health, Montgomery, Ala.

The flood water rose above the ground level at every well. The air-lift or northern wells have well heads wherein the air exhausts and the water is collected before leaving for the collecting basins. These wells were assumed to be tight, as no water or air leaks ever showed. The well heads remained in each instance above high water level. The eastern wells were assumed to be tight, as the outside casing terminated in a concrete box, through one vertical side of which the discharge tee on the discharge pipe was run. This box was covered with the base plate of the motor, the joint being well cemented, and the stuffing box for the vertical shaft water-tight.

The county health officer became anxious about the water and went to the plant at noon on December 11. The four basins are numbered consecutively from west to east. Basin 1 was found to contain clear water; the flood water level being above the ground level but 5 feet below the basin rim. The water in Basin No. 2 was low, and slightly turbid. In Basin No. 3 the supply was also low, the water being very turbid. Basin No. 4 contained slightly turbid water. The depth of flood water increased from Basin No. 1 to Basin No. 4, the depth about the latter being 2 feet or more. A slight infiltration below ground was seen in Basins No. 2 and No. 3. These were at once cut out of service and Basins No. 1 and No. 4 used for pumping.

Samples for analysis were taken from the mains and the analyses made in the State Laboratory. *B. coli* showed in all dilutions, with the total bacteria too numerous to count.

No pumps were operating on December 12 until 5.00 p.m., due to the water power dam having failed and the local stand-by steam plant being temporarily out of service. At this time the flood waters had receded far enough to permit an inspection of the wells at the pumping station. Two of these were found to be delivering a very turbid water. They were at once turned into Basins No. 2 and No. 3, which were not being used, but which had been connected with the outfall, so as to drain as soon as the river was low enough to permit it.

On December 13, the City Commission, in conference with the Health Officer, advised the people, through the press, to boil all water used for strictly domestic purposes. No attempt was made to sterilize the whole supply as no one connected with the Water Department was informed as to the practical methods.

Not until the morning of December 15 could the City Health Officer secure the aid of the State Sanitary Engineer, who had been held at Speigners by a railway washout. When he reached the city, a temporary chlorinating apparatus, consisting of two barrels, a curb cock to control the solution, and a feed pipe into the effluent was installed on December 15 so as to dose all the water from the air lift wells in Basins No. 1 and No. 4 at the pumping station. As Basins 2 and 3 were out of service, this cared for all the water delivered by the air lift wells, including the two cut out on account of turbidity, which had cleared up and been put back into service on account of water shortage. The 700,000-gallon filter plant, normally handling water from the river for the use of the railroads, had been flooded and put out of commission. This caused the railroads to draw on the domestic supply, which was to that extent short.

The chlorine dose was regulated by hand and controlled by the ortho-tolidine test, a residual amount of 0.2 part per million being obtained.

Samples for analysis were taken from each well.

Only one of the eastern wells was in service. The water which it delivered was entering the supply untreated, under a pressure of 120 pounds. It was not possible to chlorinate this supply as no pressure apparatus was available. An examination showed the well was not water-tight. Pine straw had been sucked in large quantities towards the foundation around the discharge pipe. Upon examination it was at once seen that one side of the concrete box forming the motor base and terminating the outside casing, was gone completely, leaving the annular space between the 16-inch outer casing and the 8-inch discharge pipe open for the entrance of the flood waters.

A two-barrel apparatus for chlorine, introduced as a solution of chloride of lime, was installed. The dose was controlled chemically as at Basins No. 1 and No. 4 and the amount was held at the same standard. When the pump was not in operation there could be heard a small stream of water splashing on the annular water surface between the outer casing and the drop pipe. This could not come from the drop pipe, as it immediately empties upon the stopping of the motor, the water running back through the centrifugal pump. This led to the belief that there was a leak in the casing which must be discovered by a mirror or by cutting the foundation, as direct sight was not possible. Any leak in this

casing was doubly dangerous, as an open ditch draining a considerable area flows within 15 feet of the well.

The results of the analyses made on the samples taken December 15 showed that the air-lift wells, which had furnished turbid water, had been grossly polluted, as were both of the eastern wells. A second set of samples was analyzed and the results confirmed those of the first set.

The basins at the pumping station are connected to the river through an overflow and blow-off pipe. The lower pipes are controlled by gate valves, the upper ones by check valves, with no gate valve in the line. The overflow pipe from Basins 1 and 2 enters one side of a tee, with a check valve between Basin 2 and the fitting. Basins 3 and 4 are so connected in series to the other arm of the tee, with the check valve between Basin 3 and the tee. It was thought possible that river water backed through the check valves, the basins, and into the wells during the period the plant was shut down. An examination showed it was impossible for river water to enter the wells this way, for the well heads were above high water. The check valves were examined, however, and one was found to have a piece of 1 by 8-inch plank about 12 inches long wedged so as to prevent the check from seating. There can be no doubt that river water entered Basin 2 through this valve.

The two air-lift wells which furnished turbid water and were found to be polluted, are dug on very low ground, which was twelve feet under water during the flood. An examination showed their construction to be different from that of the other wells. These wells are constructed of three pipes: an outside casing, 8 inches in diameter in one instance and 14 inches in the other; a water-lift pipe inside a 5-inch air pressure pipe, the two being supported on the outside casings by bushings bearing on inverted bell shaped castings resting on the casing tops.

At each well there was a space between the bell and the outside casing. Cinders had floated and stuck in this space which led to the belief that water had been sucked down. A split box, made of 2-inch kiln dried lumber, 2 by 2 by 2 feet, was bolted around the outside casing, so as to submerge any openings. A  $\frac{1}{2}$ -inch stream of water was turned on and the water went in under the bell and around the opening at the bell so fast that the box would not fill. This demonstrated the fact that water entered the well.

To demonstrate the fact that this water was pumped out of the discharge pipe after passing down 400 feet, 12 ounces of chloride of lime were added every 30 minutes for two hours, and the effluent tested. The  $\frac{1}{2}$ -inch stream ran for  $1\frac{3}{4}$  hours, when a very strong test for chlorine was obtained on the discharged water. This demonstrated without a doubt, how and where the muddy river water entered these wells.

The four wells which showed such poor results on the laboratory tests were receiving surface water which was entering directly into the wells as described. As soon as the high water receded, the contamination ceased. No stratum has been or is contaminated, as was at first thought. This is shown by the laboratory findings on the other wells, and also a test made on the eastern wells after three days of chlorinating. The chlorine was shut off, the valve on the discharge set to waste the water, and a sample taken after the chemical test showed the water free of chlorine. The water was very low in bacteria, with colon absent.